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(54) Title of the invention: Image generating system

(57) Abstract:
Problem to be solved: To provide an image generating device capable of reducing time and labor for generating a CG image suitable for a display medium expressed with a low gradation.
Solution: A CG processing part 20 is provided for generating the CG image watching a 3D model arranged in an object space from a prescribed viewpoint position and provided with a 3D model setting part 21, a 3D layout setting part 23, a gradation reduction rule setting part 25 and a rendering processing part 27. The gradation reduction rule setting part 25 sets gradation reduction rules in the case of generating the CG image expressed with the low gradation through rendering processing on the basis of the combination of the shape and surface attribute of each 3D model.

The rendering processing part 27 generates the CG image suitable for the low gradation display by replacing a specified pattern or the like according to the gradation reduction rules in the case of generating the CG image through prescribed rendering processing.

[Claims]

[Claim 1] The image generation method that generates the 2D image that represents the display object arranged in imagination 3D space from the predetermined view location. A display object specification means to specify the arrangement in the configuration, the surface attribute and the mentioned above 3D space of the mentioned above display object, a correspondence rule setting means to set up the correspondence rule that made the specific pattern correspond to the front face of the mentioned above display object. In case the 2D image that represents the mentioned above display object from the mentioned above view location is generated, about the front face of the mentioned above display object, where the mentioned above correspondence rule is set up by the mentioned above correspondence rule setting means. The image generation method characterized by having a 2D image generation means to generate the mentioned above 2D image by performing processing that the specific pattern specified by the mentioned above correspondence rule is made to correspond and lowers the number of gradation

about the front face of the mentioned above other display object.
[Claim 2] The image generation method that is also equipped with a light source location means to set up the location of the light source in the mentioned above 3D space, according to claim 1 characterized by the mentioned above 2D image generation means generating the mentioned above 2D image, taking into consideration the location of the mentioned above light source set up by the mentioned above light source location means.
[Claim 3] The image generation method characterized by generating the mentioned above 2D image that the mentioned above 2D image generation means lowered the mentioned above number of gradation in claims 1 or 2 and was expressed in the monotone.
[Claim 4] The image generation method characterized by including the information about the mentioned above specific pattern to which each partition is made to correspond when the mentioned above correspondence rule divides the front face of the mentioned above display object into a part for the several division according to claims 1-3 based at least on either lightness or saturation.
[Claim 5] The image generation method characterized by including the information about the mentioned above mutually different specific pattern to which the mentioned above each display object is made to correspond when at least either

the lightness or the saturation and tints differ of each front face of several of the mentioned above display objects of the mentioned above correspondence rule is the same according to claims 1-3.

[Claim 6] The image generation method characterized by including the information about the mentioned above specific pattern replaced with this pattern when a predetermined pattern appears in the image with which the mentioned above correspondence rule looked at the mentioned above display object from the mentioned above view location according to claims 1-3.

[Claim 7] The image generation method characterized by including the information made to correspond to the false middle gradient as which the mentioned above correspondence rule expressed at least either the lightness of the front face of the mentioned above display object or saturation with 2 gradation according to claims 1-3.

[Claim 8] The image generation method characterized by setting up the mentioned above correspondence rule where the mentioned above correspondence rule setting means took at least the configuration of the mentioned above display object and one side of arrangement into consideration according to claims 1-7.

[Claim 9] The image generation method characterized by that the mentioned above correspondence rule setting means having set up the mentioned above correspondence rule that is

different about each of several of the mentioned above display objects according to claims 1-8 and the mentioned above 2D image generation means generating an image using the mentioned above correspondence rule that the mentioned above several display objects are alike and corresponds, respectively.

[Claim 10] The image generation method that the mentioned above correspondence rule setting means has set up the mentioned above correspondence rule common to the mentioned above several display objects according to claims 1-8 characterized by that the mentioned above 2D image generation means generating an image using the mentioned above correspondence rule common to the mentioned above several display objects.

[Detailed description of the invention]

[0001]

[Field of the invention] This invention relates to the image generation method that generates the 2D image obtained when the object arranged in imagination 3D space is seen from a predetermined view location.

[0002]

[Description of the prior art] Recently, the technique of the computer graphics ("CG" is called next) that generates the 2D image obtained when the object that is the 3D body ("3D model" is called next) arranged in imagination 3D space ("object space" is called next) is seen from a

predetermined view location using a personal computer etc. is used widely.

[0003] Generation of concrete CG image is performed by as follows. First, in a modeling process, specification of 3D model arranged in object space is performed. For example, after the configuration of 3D model is set up, the attribute of the front face of each 3D model is set up. Next, it sets at a layout process and each of the location of each 3D model in object space, the location of the light source and a view location is set up. Then, rendering processing is performed and when 3D model is seen from a desired view location, CG image as a 2D image sometimes obtained is generated.

[0004]

[Problems to be solved by the invention] By the way, some surface attributes are lost and CG image generated using the conventional technique mentioned above may not be correctly displayed, if the case where a multicolor display is performed is assumed and it is going to perform the monochrome display and low gradation display that are 2 gradation displays. For example, when two balls as shown on drawing 7 are considered as a 3D model, the color of the front face of the ball of another side shall be set as red for the color of the front face of one ball green as a surface attribute. If the light source is arranged to such a 3D model in a predetermined location, it should seem to the front face of each ball that red or green becomes

dark gradually as highlighting of the part nearest to the light source is carried out and it keeps away from the light source. When these colors are monotone displayed, signs that a color changes gradually cannot express correctly and it is fair however, attaching the red with the same lightness and two green balls of each other. For this reason, after rendering processing was completed conventionally, gradation reduction processing based on lightness is performed, a different binary pattern for every gradation is set up, final CG image is generated by a user's handwork and the problem is that generation of CG image to the display medium expressed with low gradation takes great time and effort.

[0005] This invention is created in view of such point and the purpose is in offering the image generation method that can reduce the time and effort that generates CG image suitable for the display medium expressed with low gradation.

[0006]

[Means for solving the problem] In order to solve the technical problem mentioned above, the image generation equipment of this invention, when generating the 2D image that represents the display object arranged in imagination 3D space from the predetermined view location, while specifying the arrangement in the configuration, the surface attribute and 3D space of a display object with a display object specification means, after setting up the correspondence rule that made

the specific pattern correspond to the front face of a display object with a correspondence rule setting means, in case a 2D image generation means generates the 2D image (CG image) that represents the display object from the view location, the specific pattern specified by this correspondence rule about the front face of the display object with which the correspondence rule is set up is made to correspond and processing that lowers the number of gradation is performed about the front face of the other display object. When there is information that will be missing if the number of gradation is lowered simply, by making the specific pattern correspond to such information preliminary, after generating the 2D image of the high tone, the activity of lowering the number of gradation becomes unnecessary and the time and effort that generates CG image suitable for the display medium expressed with low gradation can be reduced.

[0007] Also, it is desirable to have further a light source location means to set up the location of the light source in the 3D space mentioned above and to generate CG image with a 2D image generation means, taking this set-up light source location into consideration. Since a view location can be set as arbitration, CG image of low gradation seen from the view location of arbitration is easily generable.

[0008] Also, it is desirable to generate the 2D image that lowered the number of gradation and was expressed in the monotone by the 2D image

generation means mentioned above. Although such gradation information and information on a tint are missing and unnatural CG image is obtained when CG image generated using 3D model expressed with the high tone or multiple colors is monotone displayed, by transposing this missing information to a specific pattern, it is more natural, or CG image which the user meant can be generated, without applying excessive time and effort.

[0009] Also, the information about the specific pattern to which each partition is made to correspond when the front face of (1) display object is divided into the correspondence rule mentioned above at a part for the several division based on at least either lightness or saturation, (2) when at least either the lightness of each front face of several of the mentioned above display objects or saturation is the same and tints differ. The information about the pattern of mutually different specification to which each display object is made to correspond, (3) when a predetermined pattern appears in the image that represent the display object from the view location, it is desirable to include either of informational that makes either at least the lightness of the front face of the information about the specific pattern replaced with this pattern and (4) display object or saturation correspond to the false middle gradient pattern expressed with 2 gradation. The special pattern corresponding to such information is what is not

obtained only by reducing simply the number of gradation of CG image generated using 3D model expressed with the high tone or multiple colors. Although a user's handicraft has realized after generating CG image expressed with the high tone or multiple colors, if it is the former.
In this invention, improvement in the working efficiency by automation is attained by rule replacement of such a special pattern preliminary.
[0010] Also, as for the correspondence rule setting means mentioned above, it is desirable to set up the correspondence rule that took at least the configuration of a display object and one side of arrangement into consideration. Although it may become unnatural if there are some that have various configurations also in a display object and it treats identically about a thing far from a near thing from a view, change is given to CG image of the low gradation expression generated and it can avoid giving monotony by setting up the correspondence rule, taking these into consideration.
[0011] Also, it is desirable to set up the correspondence rule about each of several display objects with the correspondence rule setting means mentioned above and to generate an image using the correspondence rule corresponding to each display object with a 2D image generation means. Since the correspondence rule that is different about each display object can be set up,

the activity that cannot cope with it is automatable in the uniform correspondence rule.
[0012] Also, it is desirable to set up the correspondence rule common to several display objects with the correspondence rule setting means mentioned above and to generate an image using the correspondence rule common to each display object with a 2D image generation means. Since uniform CG image using this correspondence rule is generable while a setup of the correspondence rule becomes easy, in order for what is necessary to be just to prepare the correspondence rule common to each display object, working efficiency can be raised.
[0013]
[Embodiment of the invention] Next, the image generation equipment of 1 operation embodiment that applied this invention is explained in details, referring to a drawing.
[0014] Drawing 1 is drawing showing the configuration of the image generation equipment 100 of this operation embodiment. The image generation equipment 100 shown on this drawing is constituted including 3D data storage part 10, CG processing part 20, a control unit 30, 2D data storage part 40, the display and control part 42 and the display unit 44.
[0015] 3D data storage part 10 stores the location of data (configuration data of each 3D model, data about a surface attribute, etc.) and the background data of those required since 3D model arranged in

object space is specified and each 3D model in object space, the location of the light source and a view location. In case CG image in the case of being preliminary stored in 3D data storage part 10 is generated, it is possible to input these various data each time. For example, in this operation embodiment, in case CG image is generated, these data shall be generated each time and shall be stored in 3D data storage part 10.

[0016] CG processing part 20 generates CG image that represents 3D model arranged in object space from the predetermined view location and is constituted including 3D model setting part 21, 3D layout setting part 23, the gradation reduction rule setting part 25 and the rendering processing part 27.

[0017] 3D model setting part 21 sets up various data required since each 3D model arranged in object space is specified. For example, the configuration data that specify the configuration of each 3D model and the surface attribute data that specifies the attribute of the front face of each 3D model are included in this data. Also, the lightness, the saturation, the surface tint and surface texture of each 3D model (the quality of the materials, such as a reflection factor and permeability, pattern of the material itself, etc.) are included in this surface attribute data. When monochrome (2 gradation) or CG image of low gradation is especially generated using the conventional technique, even if the information on the tint

included in this surface attribute data or texture may be missing and it generates such a CG image simply, a result tha a user means is not obtained.
[0018] 3D layout setting part 23 sets up the location in object space (arrangement) about each 3D model with which the configuration and the surface attribute were set up by 3D model setting part 21. Also, 3D layout setting part 23 sets up the location and class of light source that are arranged in object space. For example, assignment of the light source for a parallel ray, a spot and cones is attained besides the simplest point light source as a class of light source. Also, 3D layout setting part 23 sets up a view location. These various setups are performed according to a user's directions input.
[0019] The gradation reduction rule setting part 25 sets up the gradation reduction rule as the correspondence rule used in case CG image of low gradation that has monochrome or the number of gradation beyond it is generated. Drawing 2 - drawing 4 are drawings showing the example of the gradation reduction rule. There is the following as an example of the gradation reduction rule.
[0020] 1) When lightness or saturation changes gradually, classify the condition of the change into several steps and make a pattern that it differs in each partition correspond. For example, the case where change spacing of hatching to which each partition is made to correspond as change of this lightness is classified into plurality (four metaphors)

as it is shown on drawing 2, although it becomes gradually dark as it is bright in the front face of the ball nearest to the light source when an one direction to a lighting is performed in the ball as a 3D model and it keeps away and it becomes dark or half tone dot meshing processing is performed is equivalent to this.

[0021] 2) Make other specific patterns correspond to the specific pattern that it appears in 3D model front face. For example, since the difference of the texture by this highlighting does not appear so much in CG image of low gradation etc., as shown on drawing 3, the case where this highlights part is transposed to a specific pattern (for example, star pattern) is equivalent to this when performing a lighting in the ball as a 3D model from an one direction, carrying out highlighting of the front face of the ball nearest to the light source is performed.

[0022] 3) Make a pattern that differs to each 3D model correspond to several 3D models with which lightness or saturation is the same with models and tints differ. For example, if one side uses this and generates CG image of monochrome in red, when another side is green, since the difference in the tint of each ball cannot express only by change of lightness etc., as shown on drawing 4, the case where it expresses using a pattern (for example, hatching and half tone dot meshing) that is made to correspond to each tint and is different there are two balls as a 3D model and is equivalent to this.

[0023] The rendering processing part 27 performs rendering processing based on the detail data of each 3D model set up by 3D model setting part 21, the arrangement condition of each 3D model set up by 3D layout setting part 23, a light source location, a view location, etc. For example, as the typical technique of rendering processing, various kinds of technique, such as the ray tracing method and a scan-line algorithm or the partialness ray tracing method into which these were developed further, is known. Also, in this rendering processing, when it corresponds to the gradation reduction rule set up by the gradation reduction rule setting part 25 mentioned above, a change of a pattern that the front face of 3D model is given according to this rule etc. is made.

[0024] Also, a control unit 30 is for inputting various kinds of operator guidance by the user and the keyboard for inputting an alphabetic character and a figure, the mouse as a pointing device, etc. are included. A user can operate this control unit 30, looking at various kinds of actuation screens displayed on a display unit 44 and can specify the location in the configuration and surface attribute of 3D model and object space, a light source location, a view location, etc. as arbitration.

[0025] 2D data storage part 40 stores CG image data generated by CG processing part 20. This CG image data is sent to a display and control part 42 and is displayed on the screen of a display unit 44.

[0026] 3D model setting part 21 and 3D layout setting part 23 that were mentioned above correspond to a display object specification means, the reduction gradient rule setting part 25 corresponds to rule setting means, the rendering processing part 27 corresponds to a 2D image generation means and 3D layout setting part 23 corresponds to a light source location means, respectively.
[0027] The image processing system 100 of this operation embodiment has such configuration and the actuation is explained next.
[0028] Drawing 5 is the flow chart showing the operations sequence of the image processing system 100 that generates CG image expressed by low gradation display. First, 3D model setting part 21 in CG processing part 20 carries out a modeling process and it sets up the surface attribute of each 3D model while it sets up the configuration of each 3D model arranged in predetermined object space (step 100) (step 101). For example, when two balls as a 3D model as shown on drawing 7 are considered, the configuration and the lightness of a front face of each ball, a tint, texture, etc. are set up.
[0029] Next, in a layout process, 3D layout setting part 23 sets up the location of 1 arranged in object space, or several light sources while opting for the arrangement in the object space of each 3D model with which the configuration and the surface attribute were set up in the modeling process

mentioned above (location) (step 102) (step 103). In addition, as mentioned above, assignment of the light source for forming the parallel ray, spot and cone other than the general point light source as a class of light source is possible and 3D layout setting part 23 also sets up the class of light source at the same time it sets up the location of the light source. But, it is possible not to take the location or class of light source into consideration at all like in case it is not necessary to necessarily choose either from the light sources of several classes and the whole 3D model is illuminated uniformly. Also, 3D layout setting part 23 sets up the view location that is needed by the rendering processing that performs CG image generation (step 104).

[0030] Also, in a layout process, the gradation reduction rule setting part 25 sets up the gradation reduction rule at the time of rendering processing generating CG image expressed with low gradation based on the configuration of each 3D model and the combination of a surface attribute (step 105). For example, when the information that is missing when rendering processing is performed without applying the gradation reduction rule, as an example was shown on drawings 2 - 4 is preliminary transposed to a specific pattern or low gradation is formed, a pattern to replace intentionally is set up and these contents of a setting are sent to the rendering processing part 27.

[0031] Next, the rendering processing part 27 carries out predetermined rendering processing (step 106). Although various kinds of technique this rendering processing is generally performed from the former is used, if CG image of a midcourse phase is obtained by rendering processing, the rendering processing part 27 will apply the gradation reduction rule sent from the gradation reduction rule setting part 25 to CG image of this midcourse phase and will carry out replacement processing of a pattern, lightness, etc. For example, when a highlights part arises in some balls as a 3D model, as shown on drawing 3, processing that transposes the highlights part to the asterisk pattern is performed. Also, when the lightness of the front face of the ball as a 3D model changes gradually along an one direction according to relative physical relationship with the light source, as shown on drawing 2, according to lightness, a part for the several division is set up and a pattern that it differs for every partition is matched.

And when the tints of the front face of each ball differ, as shown on drawing 4, a separate pattern (for example, hatching and half tone dot meshing) is matched with each of a different color. Thus, after the rendering processing part 27 performs rendering processing using the technique used from the former and generates CG image of a midcourse phase, it generates final CG image that performed replacement processing of a pattern

that the gradation reduction rule set up preliminary was followed etc. and fitted the low gradation display. After this CG image is stored in 2D data storage part 40, it is read by the display and control part 42 and it is displayed on the screen of a display unit 44.

[0032] Thus, in case the image processing system 100 of this operation embodiment generates CG image by which the low gradation expression was carried out, it has set up a pattern that it replaces in consideration of various kinds of information that will be missing if the number of gradation was only lowered simply in the case of rendering processing and can generate CG image suitable for the display medium (for example, paper medium that performs monochrome displays, such as a liquid crystal display of low gradation and a comic magazine) expressed with low gradation. Also, since not only various kinds of information that will be missing if the number of gradation was only lowered simply but a specific pattern can also be transposed to the pattern of the arbitration that the user set up, a pattern were suitable for especially CG image expressed with low gradation can be used if needed. For example, although an individual pattern in that liking of the original author was reflected may be used abundantly rather than it lowers only the number of gradation of CG image of the high tone and obtains a realistic image more when generating the image of the comic magazine generally expressed with the small number of

gradation. Since individual CG image using such special pattern is automatically generable in the case of rendering processing by setting up such an individual pattern as one of the gradation reduction rule preliminary, the time and effort at the time of generating images, such as a comic magazine, can be reduced and improvement in working efficiency can be achieved.

[0033] By the way, although CG image generation in the operation embodiment mentioned above considered the case where replacement processing of a pattern that it is based on the gradation reduction rule for the whole CG image of the midcourse phase acquired by rendering processing was performed, it is possible to set up the gradation reduction rule for every surface attribute of each 3D model.

[0034] Drawing 6 is the flow chart showing the modification of the operations sequence of the image processing system 100 that generates CG image expressed by low gradation display and the operations sequence in the case of setting up the gradation reduction rule for every surface attribute of each 3D model is shown.

[0035] First, 3D model setting part 21 in CG processing part 20 carries out a modeling process and it sets up the surface attribute of each 3D model while it sets up the configuration of each 3D model arranged in predetermined object space (step 200) (step 201). Next, the gradation reduction rule setting part 25 sets up the gradation

reduction rule at the time of rendering processing generating CG image expressed with low gradation for every surface attribute of each 3D model (step 202). A setup of the gradation reduction rule by this gradation reduction rule setting part 25 is performed according to the individual for every surface attribute of each 3D model and the different gradation reduction rule to a different 3D model is set up. Thus, it becomes possible to apply the reduction gradation rule that attaches hatching that divides change of lightness into a part for the several division and is different for every partition about 3D model of 1, to change the divisional division approach about other 3D models or to apply the gradation reduction rule that transposes a specific pattern to the pattern of arbitration.

[0036] Next, in a layout process, 3D layout setting part 23 sets up the location in the object space of each 3D model with which the configuration, surface attribute and gradation reduction rule was set up in the modeling process mentioned above (step 203), the location (step 204) of the light source and a view location (step 205). After these setup of various kinds of is completed, the rendering processing part 27 carries out predetermined rendering processing (step 206). Although various kinds of technique this rendering processing is generally performed from the former is used, in case CG image corresponding to the surface attribute of each 3D model is generated,

when the gradation reduction rule corresponding to each surface attribute is set up, replacement of a specific pattern etc. is carried out with the application of this and final CG image suitable for a low gradation display is generated.

[0037] Thus, in case CG image by which the low gradation expression was carried out is generated, the gradation reduction rule corresponding to each of the surface attribute of each 3D model is set up and that attaches a pattern that it differs in each of each 3D model etc. is made. Thus, in the uniform gradation reduction rule, the activity that cannot respond can be automated, the time and effort that generates CG image expressed with low gradation can be reduced sharply and working efficiency can be raised.

Since the gradation reduction rule can be made to correspond for every surface attribute of each 3D model especially, attaching a pattern that differs for every 3D model etc. is made, gives change to CG image of the low gradation expression generated and it can avoid giving monotony.

[0038] In addition, this invention is not limited to the above mentioned operation embodiment and various modifications of implementation within the limits of the claims of this invention is possible for it. For example, although the gradation reduction rule setting part 25 included in CG processing part 20 set up the gradation reduction rule corresponding to the configuration and surface attribute of each 3D model, it takes the depth

information on each 3D model in object space, i.e., the positional information of each 3D model, into consideration and it is possible to set up the gradation reduction rule.
For example, when two 3D models with the same configuration and a surface attribute exist, it is possible to set up the gradation reduction rule where a complicated pattern is attached in CG image by which the low gradation expression was carried out about 3D model near a view location and an easy pattern is attached in CG image by which the low gradation expression was carried out about 3D model far from a view location and that differs mutually.
[0039] Also, a pattern that attaches (for example, hatching and half tone dot mesh that has different spacing) that classify extent of this change into several partitions and it differs for every partition, respectively, with the operation embodiment when the surface lightness and the saturation of 3D model change gradually, it is possible to change gradually the false halftone expressed by the binary image in accordance with extent of change of lightness or saturation. For example, the pattern constituted by a halftone dot and the dither as false halftone expressed by the binary image can be used. What is necessary is just to change the diameter of a halftone dot gradually according to change of lightness or saturation, in changing gradually the false halftone expressed using the halftone dot. Also, what is necessary is just to

change gradually the percentage of the white pixel included in a dither matrix and a black pixel, in changing gradually the false halftone expressed using the dither.

[0040] Also, it is possible to combine the generation method of CG image explained using the generation method and drawing 6 of CG image explained using drawing 5. That is, change is given to CG image by little time and effort and it can avoid giving monotony by applying the special gradation reduction rule, in order to make a different individual production from other 3D models to 3D model to emphasize like the hero who appears in a comic magazine and applying the general gradation reduction rule to other 3D models.

[0041]

[Effect of the invention] As mentioned above, when there is information that will be missing if the number of gradation is lowered simply according to this invention, by making the specific pattern correspond to such information preliminary, after generating the 2D image, the activity of lowering the number of gradation becomes unnecessary and the time and effort that generates CG image suitable for the display medium expressed with low gradation can be reduced.

[Brief description of the drawings]

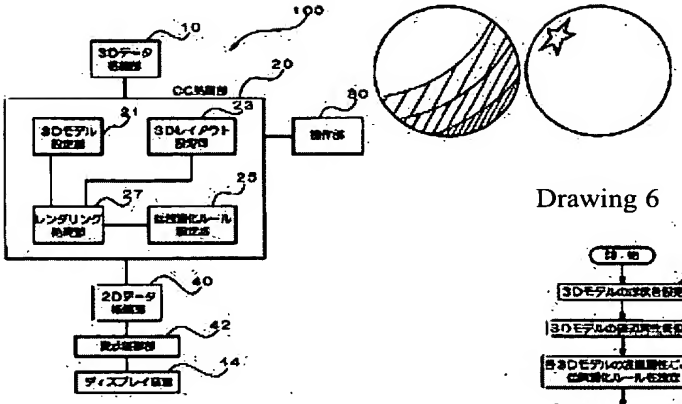
[Drawing 1] is drawing showing the configuration of the image generation equipment of 1 operation embodiment.

[Drawing 2] is drawing showing the example of the gradation reduction rule.
[Drawing 3] is drawing showing the example of the gradation reduction rule.
[Drawing 4] is drawing showing the example of the gradation reduction rule.
[Drawing 5] is the flow chart showing the operations sequence of the image processing system that generates CG image expressed with low gradation.
[Drawing 6] is the flow chart showing the modification of the operations sequence of the image processing system that generates CG image expressed with a low gradation display.
[Drawing 7] is drawing showing the example of 3D model.

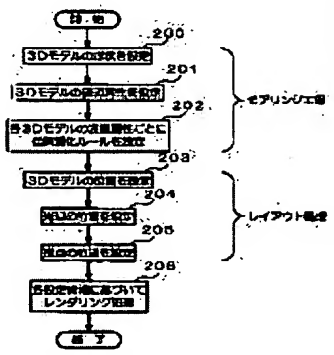
[Description of numbers]

10 3D Data storage part
20 CG Processing part
21 3D model setting part
23 3D layout setting part
25 Gradation reduction rule setting part
27 Rendering processing part
30 Control unit
40 2D Data storage part
42 Display and control part
44 Display unit
100 Image generation equipment

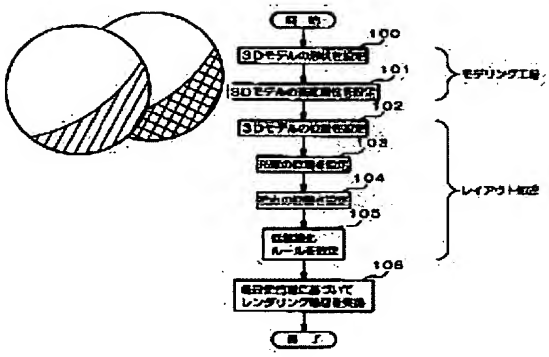
Drawing 1 Drawing 2 Drawing 3



Drawing 6



Drawing 4 Drawing 5



Drawing 7